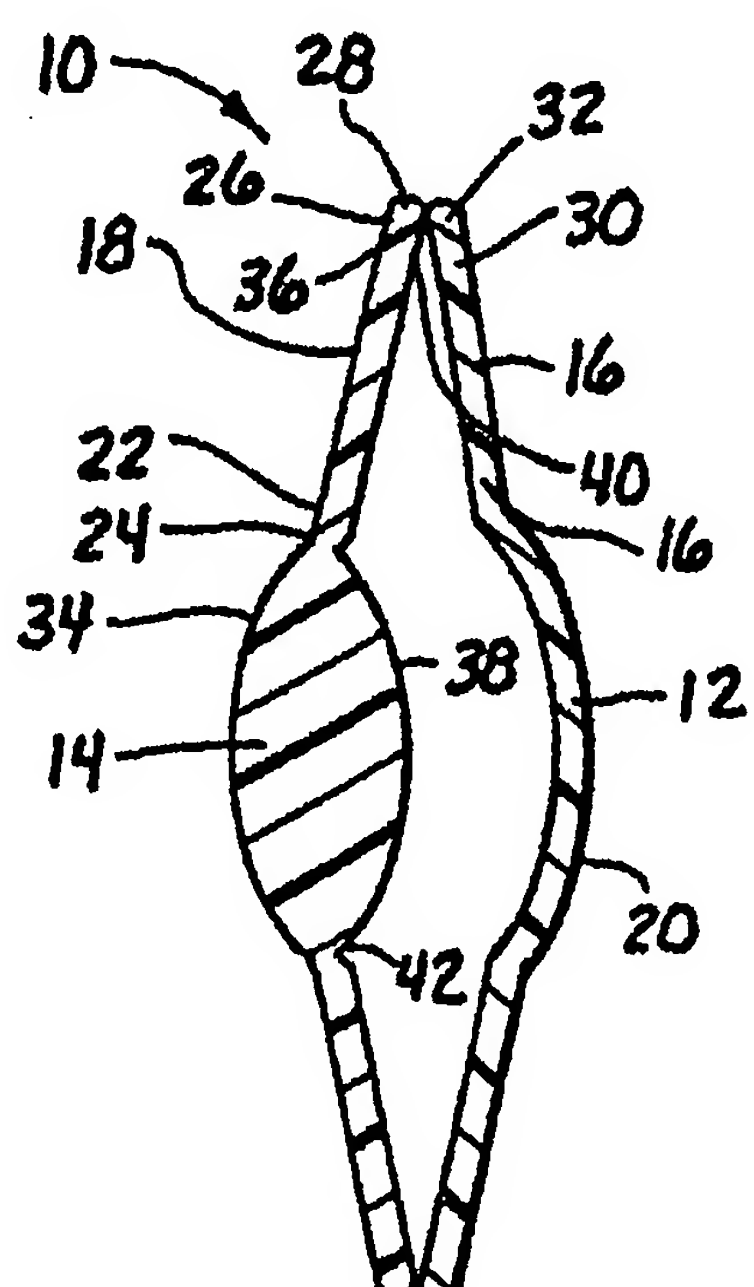




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<p>(54) Title: INTRAOCULAR LENS COMBINATIONS</p> <p>(57) Abstract</p> <p>Intraocular lens combinations (10) are provided which include a first optic (13) having a negative optical power and being adapted to be placed in a substantially fixed position in a mammalian eye. A second optic (14) having a higher optical power than the first optic (13) is provided. In addition, a movement assembly (18) is provided which is coupled to the second optic (14) and is adapted to cooperate with the eye to effect accommodating movement of the second optic (14) in the eye. Very effective accommodation is provided with the present intraocular lens combination. The present combinations (10) can be effectively positioned to effectively inhibit or reduce the risk of posterior capsular opacification (PCO).</p> 		

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## INTRAOCULAR LENS COMBINATIONS

### Cross Reference to Related Application

This application claims the benefit of U.S. Provisional Application 60/132,085 filed April 30, 1999.

### Background of the Invention

The present invention relates to intraocular lens combinations. More particularly, the invention relates to intraocular lens combinations which are adapted to provide substantial benefits, such as accommodating movement and/or  
5 inhibition of posterior capsule opacification (PCO) in the eye.

The human eye includes an anterior chamber between the cornea and iris, a posterior chamber, including by a capsular bag, containing a crystalline lens, a ciliary  
10 muscle, a vitreous chamber behind the lens containing the vitreous humor, and a retina at the rear of this chamber. The human eye has a natural accommodation ability. The contraction and relaxation of the ciliary muscle provides the eye with near, intermediate and distant vision. This  
15 ciliary muscle action shapes the natural crystalline lens to the appropriate optical configuration for focusing light rays entering the eye on the retina.

After the natural crystalline lens is removed, for example, because of cataract or other condition, a  
20 conventional, monofocal IOL can be placed in the posterior chamber. Such a conventional IOL has very limited, if any, accommodating ability. However, the wearer of such an IOL continues to require the ability to view both near and far (distant) objects. Corrective spectacles may be employed  
25 as a useful solution. Recently, multifocal IOLs without accommodating movement have been used to provide near/far vision correction.

Attempts have been made to provide IOLs with accommodating movement along the optical axis of the eye as an alternative to shape changing. Examples of such attempts are set forth in Levy U.S. Patent 4,409,691 and  
5 several patents to Cumming, including U.S. Patents 5,674,282 and 5,496,366. The disclosure of each of these patents is incorporated herein by reference.

One problem that exists with such IOLs is that they often cannot move sufficiently to obtain the desired  
10 accommodation. The degree of accommodation has been closely related to the lens prescription of the individual patient. In addition, the presence of such lenses can result in cell growth from the capsular bag onto the optics of such lenses. Such cell growth, often referred to as  
15 posterior capsule opacification (PCO), can interfere with the clarity of the optic to the detriment of the lens wearer's vision.

It would be advantageous to provide IOLs adapted for accommodating movement, which can preferably achieve an  
20 acceptable amount of accommodation and/or a reduced risk of PCO.

#### Summary of the Invention

New intraocular lens combinations (ILCs) have been disclosed. The present ILCs provide distance, near and  
25 intermediate vision through position, preferably axial position, changes in the eye. The present combinations preferably enhance the degree of accommodation achieved in spite of the movement and space limitations within the eye. One advantage of the present ILCs is the ability to  
30 standardize the prescription or optical power of the moving or accommodating lens of the ILC. Thus, the required amount of movement in the eye to achieve accommodation can be substantially the same for all patients. This greatly

facilitates the design of the moving or accommodating lens. Further, with at least certain of the present ILCs, inhibition of PCO is obtained. The present ILCs are relatively straightforward in construction, can be  
5 implanted or inserted into the eye using systems and procedures which are well known in the art and function effectively with little or no additional treatments or medications being required.

In one broad aspect of the present invention,  
10 intraocular lens combinations (ILCs) comprise a first optic, second optic and a movement assembly. The first optic has a negative optical power and is adapted to be placed in a substantially fixed position in a mammalian eye. The second optic has a higher optical power than the  
15 first optic. The movement assembly is coupled to the second optic and is adapted to cooperate with the eye, for example, the zonules, ciliary muscle and capsular bag of the eye, to effect accommodating movement of the second optic in the eye.

20 Advantageously, the second optic has a high plus optical power to reduce the amount of movement, for example, axial movement, in the eye needed to provide accommodation for intermediate and near vision. The negative or minus optical power of the first optic  
25 compensates for the excess plus or positive optical power in the first optic. The use of such a compensating lens, that is the first optic having a negative optical power, can allow for standardization of the optical power correction in the second optic. In other words, the  
30 optical power of the second optic, that is the movable optic, can be approximately equal from optic to optic, while the optical power of the first optic, that is the fixed optic, is adjusted from optic to optic to meet the specific vision correction needs (prescription) of each  
35 individual patient. Consequently, the required amount of

movement of the second optic in the eye can be approximately the same for all patients.

The present ILCs provide accommodation, preferably an acceptable degree of accommodation, in spite of movement and space limitations in the eye. For example, the maximum theoretical amount of axial movement for a simple disc lens having an overall diameter of 11 millimeters (mm) and an optic diameter of 5 mm that undergoes 1 mm of compression in its diameter is about 1.65 mm. The amount of axial movement required for a plus 15 diopter optic to provide 2.5 diopters of additional power in the spectacle plane is about 2.6 mm. However, a plus 30 diopter optic requires only 1.2 mm of axial movement to provide 2.5 diopters of additional power in the spectacle plane. Thus, by increasing the plus power of the second optic, which is adapted for accommodating movement, a reduced amount of movement is needed to achieve higher or enhanced degrees of accommodation. The first or fixed optic preferably has a minus power to compensate for the excess plus power in the second optic.

The present ILCs preferably include first and second optics with optical powers which provide a net plus optical power. To illustrate, assume that the patient requires a plus 15 diopter correction. The first optic is provided with a minus 15 diopter optical power and the second optic with a plus 30 diopter optical power. The net optical power of this ILC is approximately the sum of minus 15 diopters and plus 30 diopters or plus 15 diopters, the desired prescription for the patient in question. The powers of the first and second optics are only approximately additive since the net power of the combination also depends on other factors including, but not limited to, the separation of the two optics, the magnitude of the power of each individual optic and its location in the eye and the like factors. Also, by

adjusting the optical power of the first optic, the net optical power of the ILC can be adjusted or controlled even though the optical power of the second optic is standardized or remains the same, for example, at a plus 30  
5 diopter optical power. By standardizing the optical power of the second optic, the amount of movement in the eye required to obtain a given level of accommodation is substantially the same, and preferably well within the space limitations in the eye, from patient to patient.

10 In one very useful embodiment, the movement assembly comprises a member including a proximal end region coupled to the second optic and a distal end region extending away from the second optic and adapted to contact a capsular bag of the eye. Such movement assembly may completely  
15 circumscribe the second optic or may be such as to only partially circumscribe the second optic.

The second optic preferably is adapted to be positioned in the capsular bag of the eye.

The first optic may be coupled to a fixation member,  
20 or a plurality of fixation members, adapted to assist in fixating the first optic in the eye. Each fixation member preferably has a distal end portion extending away from the first optic. In one embodiment, the distal end portion of the fixation member is adapted to be located in the  
25 capsular bag of the eye. Alternately, the distal end portion of the fixation member may be located in contact with a sulcus of the eye. As a further alternate, the distal end portion of the fixation member may be adapted to be located in an anterior chamber of the eye.

30 The first optic may be located posterior in the eye relative to the second optic or anterior in the eye relative to the second optic. In a useful embodiment, the first optic is adapted to be positioned in contact with the posterior wall of the capsular bag of the eye. This  
35 positioning of the first optic provides for effective



compensation of the plus or positive vision correction power of the second optic. In addition, by having the first optic in contact with the posterior wall of the capsular bag, cell growth from the capsular bag onto the ILC, and in particular onto the first and second optics of the ILC, is reduced. This, in turn, reduces the risk of or inhibits posterior capsule opacification (PCO).

In one embodiment, the fixation member or members and the movement assembly are secured together, preferably permanently secured together. Thus, when inserting the ILC into the eye, a single combined structure can be inserted. This reduces the need to position the first and second optics relative to each other. Put another way, this feature allows the surgeon to very effectively and conveniently position the ILC in the eye with reduced surgical trauma to the patient.

The fixation member and movement assembly may be secured, for example, fused, together at the distal end portion of the fixation member and the distal end region of the movement assembly.

In another broad aspect of the present invention, ILCs are provided which comprise a first optic having a posterior surface adapted to be positioned in contact with a posterior wall of the capsular bag of the eye; a second optic adapted to focus light toward a retina of the eye; and a movement assembly coupled to the second optic and adapted to cooperate with the eye to effect accommodating movement of the second optic in the eye. The first optic has a substantially plano optical power or a negative optical power. These ILCs are particularly adapted to inhibit PCO.

The first optic of these combinations preferably is adapted to be placed in a substantially fixed position in the eye. The posterior surface of the first optic advantageously is configured to substantially conform to a



major portion, that is, at least about 50%, of the posterior wall of the capsular bag of the eye in which the combination is placed. More preferably, the posterior surface of the first optic is configured to substantially conform to substantially all of the posterior wall of the capsular bag. Such configuration of the first optic is very useful in inhibiting cell growth from the eye onto the first and second optics and in inhibiting PCO.

In one embodiment, the first optic has a substantially plano optical power and the second optic has a far vision correction power. In an alternate embodiment, the first optic has a negative optical power and the second optic has a positive optical power, more preferably, so that the optical powers of the first and second optics provide a net plus optical power in the eye in which the combination is placed.

In a very useful embodiment, the first optic includes an anterior surface and at least one projection extending anteriorly from this anterior surface. The at least one projection is positioned to limit the posterior movement of the second optic in the eye. Thus, the movement of the second optic is effectively controlled to substantially maintain the configuration of the combination and/or to substantially maintain an advantageous spacing between the first and second optics.

The movement assembly may be structured and functions similarly to movement assembly of the previously described ILCs.

The first optic may have a fixation member or members coupled thereto. The fixation member or members are adapted to assist in fixating the first optic in the eye, that is in contact with the posterior wall of the capsular bag of the eye. In one embodiment, the first optic itself is configured and/or structured so that no fixation member or members are needed to maintain the first optic in

contact with the posterior wall of the capsular bag of the eye. The first optic and the movement assembly of these ILCs may be secured together.

In general, the first and second optics of the present ILCs may be made of any suitable materials. Preferably; the first and second optics are made of polymeric materials. More preferably, the first and second optics and the movement assembly, and the fixation member(s), if any, are deformable for insertion through a small incision in the eye.

The present movement assemblies are sufficiently flexible to facilitate movement of the second optic in the eye upon being acted upon by the eye. In one very useful embodiment, the movement assembly includes a hinge assembly, preferably adapted and positioned to facilitate the accommodating movement of the second optic.

In those embodiments in which the first optic has a substantially plano optic power, the second optic preferably has a far vision correction power, more preferably such a power for infinity, in the unaccommodated state.

In a further broad aspect of the present invention, methods for inserting an ILC in an eye are provided. Such methods comprise providing an ILC in accordance with the present invention, as described herein. The ILC is placed into the eye, for example, in the capsular bag of the eye or partly in the capsular bag of the eye, using equipment and techniques which are conventional and well known in the art. The ILC is placed in a rest position in the eye, for example, a position so that the eye, and in particular the ciliary muscle and zonules of the eye, effectively cooperate with the movement assembly to move the second optic of the ILC anteriorly in the eye from the rest position to provide for positive accommodation. No treatments or medications, for example, to paralyze the ciliary muscle, to facilitate fibrosis or otherwise

influence the position of the ILC in the eye, are required.

Preferably, the first and second optics and the movement assembly are deformed prior to being placed into the eye. Once the ILC is placed in the eye, and after a  
5 normal period of recovery from the surgical procedure, the ILC, in combination with the eye, provides the mammal or human wearing the ILC with effective accommodation, preferably with reduced risk of PCO. In the unaccommodated state, the ILC preferably provides the mammal or human  
10 wearing the ILC with far vision correction.

Any and all features described herein and combinations of such features are included within the scope of the present invention provided that the features of any such combination are not mutually inconsistent.

15 Further aspects and advantages of the present invention are set forth in the following detailed description and claims, particularly when considered in conjunction with the accompanying drawings in which like parts bear like reference numerals.

#### 20 Brief Description of the Drawings

Fig. 1 is a front plan view of an ILC in accordance with the present invention.

Fig. 2 is a cross-sectional view taken generally along line 2-2 of Fig. 1.

25 Fig. 3 is a cross-sectional view of an additional ILC in accordance with the present invention.

Fig. 4 is a fragmentary sectional view of an eye in which an alternate ILC in accordance with the present invention has been implanted.

30 Fig. 5 is a fragmentary sectional view of an eye in which another ILC in accordance with the present invention has been implanted.

Fig. 6 is a front plan view of an intraocular lens

useful in an ILC in accordance with the present invention.

#### Detailed Description of the Drawings

Referring now to Figs. 1 and 2, an ILC according to the present invention, shown generally at 10, includes a  
5 first optic 12, a second optic 14, a disc type fixation member 16 and a disc type movement assembly 18.

The first optic 12 has substantially plano optical power and is adapted to be held in a fixed position, for example, at least partially by the fixation member 16.  
10 When the ILC 10 is positioned in a human eye, the posterior surface 20 of first optic 12 is in contact with the inner posterior wall of the capsular bag of the eye. This positioning of optic 12 is very effective in reducing or inhibiting endothelial cell growth from the capsular bag  
15 onto the first optic 12. In effect, the positioning of the first optic 12 against the posterior surface of the capsular bag inhibits or reduce the risk of PCO.

The second optic 14 includes a distance vision correction power. The movement assembly 18 extends  
20 radially outwardly from second optic 14 and fully circumscribes the second optic 14. Movement assembly 18 has a proximal end region 22 which is coupled to the second optic 14 at first optic periphery 24.

Movement assembly 18 extends radially outwardly to a  
25 distal end region 26 including a peripheral zone 28.

Fixation member 16 includes a distal end portion 30 including a peripheral area 32. The movement assembly 18 and fixation member 16 are fused together at the peripheral zone 28 and peripheral area 32. Thus, the entire ILC 10 is  
30 a single unitary structure. The first optic 12 and fixation member 16 can be manufactured separately from second optic 14 and movement assembly 18 and, after such separate manufacture, the fixation member and movement

assembly can be fused together. Alternately, the entire ILC 10 can be manufactured together. Also, if desired, the first optic 12 and fixation member 16 can be inserted into the eye separately from the second optic 14 and movement  
5 assembly 18. Thus, ILC 10 can comprise a plurality of separate components.

Movement assembly 18 extends outwardly from second optic 14 sufficiently so that the distal end region 26, and in particular the peripheral zone 28 of the distal end  
10 region, is in contact with the inner peripheral wall of the posterior capsular bag when the ILC 10 is implanted in the eye.

As best seen in Fig. 2, when ILC 10 is at rest, the second optic 14 is positioned vaulted anteriorly relative  
15 to the distal end region 26 of movement assembly 18. In other words, the anterior surface 34 of second optic 14 is anterior of the anterior surface 36 of movement assembly 18 at distal end region 26 and/or the posterior surface 38 of the second optic 14 is anterior of the posterior surface 40  
20 of the movement assembly at the distal end region.

The first and second optics 12 and 14 may be constructed of rigid biocompatible materials, such as polymethyl methacrylate (PMMA), or flexible, deformable materials, such as silicone polymeric materials, acrylic  
25 polymeric materials, hydrogel polymeric materials, and the like, which enable the optics 12 and 14 to be rolled or folded for insertion through a small incision into the eye. Although the first and second optics 12 and 14 as shown are refractive lens bodies, the present ILCs can include at  
30 least one diffractive lens body, and such embodiment is included within the scope of the present invention.

As noted previously, first optic 12 has a substantially plano or zero optical power. Second optic 14 is prescribed for the wearer of ILC 10 with a baseline or  
35 far (distance) diopter power for infinity. Thus, the

wearer of ILC 10 is provided with the vision correction power of second optic 14 with little or no contribution from the first optic 12.

5 The fixation member 16 and movement assembly 18, as shown, are integral (unitary) with and circumscribe the first and second optics 12 and 14, respectively. Alternately, fixation member 16 and/or movement assembly 18 can be mechanically or otherwise physically coupled to first optic 12 and second optic 14, respectively. Also, 10 the fixation member 16 and/or movement assembly 18 may only partially circumscribe first and second optics 12 and 14, respectively, and such embodiments are included within the scope of the present invention. The fixation member 16 and movement assembly 18 may be constructed from the same or 15 different biocompatible materials as first and second optics 12 and 14, and preferably are made of polymeric materials, such as polypropylene silicone polymeric materials, acrylic polymeric materials, and the like. Movement assembly 18 has sufficient strength and rigidity 20 to be effective to transfer the force from the ciliary muscle of the eye so that the second optic 14 is movable axially in the eye to effect accommodation.

Movement member 18 includes a region of reduced thickness 42 located at the proximal end region 22. This 25 area of reduced thickness, which completely circumscribes the second optic 14, acts as a hinge to provide additional flexibility to the movement member 18 to extenuate or amplify the accommodating movement of second optic 14 in response to the action of the ciliary muscle and zonules.

30 The fixation member 16 and movement assembly 18 preferably are deformable, in much the same manner as first and second optics 12 and 14 are deformable, to facilitate passing ILC 10 through a small incision into the eye. The material or materials of construction from which fixation 35 member 16 and movement assembly 18 are made are chosen to



provide such members with the desired mechanical properties, e.g., strength and/or deformability, to meet the needs of the particular application involved.

5 The ILC 10 can be inserted into the capsular bag of a mammalian eye using conventional equipment and techniques, for example, after the natural crystalline lens of the eye is removed, such as by using a phacoemulsification technique. The ILC 10 preferably is rolled or folded prior to insertion into the eye, and is inserted through a small  
10 incision into the eye and is located in the capsular bag of the eye.

The ILC 10 in the eye is located in a position in the capsular bag so that the posterior surface 20 of first optic 12 is maintained in contact with the inner posterior  
15 wall of the capsular bag. As noted previously, positioning the first optic 12 in contact with the posterior wall of the capsular bag reduces the risk of or inhibits cell growth from the capsular bag onto the first optic 12 which, in turn, reduces or inhibits PCO. The ciliary muscle and  
20 zonules of the eye provide force sufficient to move axially second optic 14 sufficiently to provide accommodation to the wearer of ILC 10.

The ILC 10 should be sized to facilitate the movement of the second optic 14 in response to the action of the  
25 ciliary muscle and zonules of the eye in which the ILC is placed.

If the ILC 10 is too large, the ciliary muscle and zonules will be inhibited from effectively contracting/relaxing so that the amount of accommodating  
30 movement will be unduly restricted. Of course, if the ILC 10 is too small, the second optic 14 will be ineffective to focus light on the retina of the eye, may cause glare and/or the movement member may not cooperate with the eye to effect the desired amount of accommodating movement. If  
35 the ILC 10 is to be included in an adult human eye, the

first and second optics 12 and 14 preferably have diameters in the range of about 3.5 mm to about 7 mm, more preferably in the range of about 5 mm to about 6 mm. The ILC 10 preferably has an overall maximum diameter, with the movement assembly 18 in the unflexed or rest state, in the range of about 8 mm to about 11 mm or about 12 mm.

The present ILC 10 has the ability, in cooperation with the eye, to move the second optic 14 both posteriorly and anteriorly in the eye, to provide for both distance focus and near focus, respectively. This movement of ILC 10 advantageously occurs in response to action of the ciliary muscle and zonules, which action is substantially similar to that which effects accommodation in an eye having a natural crystalline lens. Thus, the ciliary muscle and zonules require little, if any, retraining to function in accordance with the present invention. The movement member 18, as described herein, preferably is effective to facilitate or even enhance or extenuate the axial movement of the second optic 14 caused by the action of the ciliary muscle and zonules to provide increased degree of accommodation.

Fig. 3 illustrates an additional ILC, shown generally at 110, in accordance with the present invention. Except as expressly described herein, ILC 110 is structured and functions similar to ILC 10. Components of ILC 110 which correspond to components of ILC 10 are indicated by the same reference numeral increased by 100.

One primary difference between ILC 110 and ILC 10 relates to the substitution of a posterior lens structure 40 for the first optic 12 and fixation member 16. Lens structure 40 includes a posterior face 42 which is configured to come in contact with and substantially conform to the inner posterior surface of the capsular bag of the eye in which the ILC 110 is to be placed. Thus, the surface 42 which extends around the peripheral area 44 and

across the center region 46 of the lens structure 40 is adapted to come in contact with and substantially conform to the inner posterior wall of the capsular bag. Moreover, the lens structure 40 is adapted to remain in contact with this inner posterior wall of the capsular bag and to be fixed in the eye. This configuration has been found to be very effective in inhibiting cell growth from the eye onto the ILC 110. The anterior surface 48 of lens structure 40 is configured to provide the lens structure with a substantially plano or zero optical power. Second optic 114 is prescribed for the wearer of ILC 110 with a baseline or distance or far (distance) dioptic power for infinity. Thus, the wearer of ILC 110 is provided with a vision correction power of second optic 114 with little or no contribution from the lens structure 40.

Alternately, second optic 114 has a high plus power, for example, plus 30 diopters. The lens structure 40, and in particular the region of the lens structure, defined by the anterior surface 48, which extends substantially across the entire field of vision of the wearer of ILC 110, has a minus vision correction power which is controlled to provide the correction prescription for use in the eye in which the ILC 110 is placed. For example, if this eye requires a plus 15 diopter power, the lens structure 40 has a vision correction power of approximately minus 15 diopters so that the net vision correction power of the combination of lens structure 40 and second optic 114, is plus 15 diopters.

The lens structure can be made from materials described previously with regard to first optic 12 and fixation member 16.

One additional feature of lens structure 40 relates to the anteriorly extending projections 50 which extend from the base element 52 of lens structure 40. The number of these projections 50 can range from 2 to about 6 or more.

Alternately, a continuous annulus projecting anteriorly can be provided. The purpose of the projections 50 or the continuous annulus is to limit the posterior movement of the second optic 114 and movement assembly 118. This limitation in the movement provides an additional degree of control of the ILC 110, and prevent a collapse of the ILC 110 and maintains an advantageous degree of separation between second optic 114 and anterior surface 48 of lens structure 40.

Fig. 4 illustrates the use of an alternate ILC in accordance with the present invention. This ILC, shown generally at 60 includes a first optic 62, a second optic 64 and a movement assembly 66. First optic 62 is coupled to a fixation member 68 which includes a distal end portion 70 in contact with the periphery 72 of the sulcus 73 of eye 74. Fixation member 68 is a disk fixation member which completely circumscribes the first optic 62. However, it should be noted that the disc fixation member 68 can be replaced by two or more filament fixation members or plate fixation members or other types of fixation members, many of which are conventional and well known in the art. Movement assembly 66 is coupled to second optic 64 and completely circumscribes the second optic. Second optic 64 is located in the capsular bag 76 of eye 74 and is vaulted anteriorly to some extent to enhance accommodating movement of the second optic.

Second optic 64 has a high plus power, for example, plus 30 diopters. The first optic 62 is a compensating negative or minus lens having a minus vision correction power which is controlled to provide the correct prescription for use in eye 74. For example, if the eye 74 requires a plus 15 diopter power, the first optic has a vision correction power of approximately minus 15 diopters so that the net vision correction power of the combination of first optic 62 and second optic 64 is plus 15 diopters.

The first optic 62, fixation member 68, second optic 64 and movement assembly 66 can be made from materials described previously with regard to the first optic 12, fixation member 16, second optic 14 and movement assembly 18, respectively.

In the configuration shown in Fig. 4, the fixation member 68 is in contact with the periphery 72 of the sulcus 73 of the eye 74. This is a relatively durable component of the eye and is effective to support the fixation member 68 in maintaining the first optic 62 in a fixed position.

The movement assembly 66 cooperates with the ciliary muscle 78 and zonules 80 of eye 74 to move the second optic 64 axially along optical axis 82 of the eye.

Fig. 5 illustrates another ILC, shown generally at 360, in accordance with the present invention. Except as expressly described herein, ILC 360 is structured and functions similarly to ILC 60. Components of ILC 360 which correspond to components of ILC 60 are identified by the same reference numeral increased by 300.

One primary difference between ILC 360 and ILC 60 relates to the positioning of first optic 362. Specifically, first optic 362 is located in anterior chamber 90 of eye 374. Fixation member 368 is coupled to the first optic 362 and extends outwardly and comes in contact with the angle 92 of eye 374. The arrangement of first optic 362 and fixation member 368 is such that the first optic is maintained in a substantially stationary position in the anterior chamber 90 of eye 374. The second optic 364 is adapted to be moved axially along optical axis 382 of eye 374 by the ciliary muscle 378 and zonules 380 acting on the movement assembly 366.

Fig. 6 illustrates a still further embodiment of an intraocular lens in accordance with the present invention. This intraocular lens, shown generally at 400 includes an optic 401 and four (4) equally spaced apart movement

members 403. Each of the movement members 403 includes a distal region 405 and a proximal region 407 which is coupled to the optic 401. A hinge, for example, a linear hinge, such as a reduced thickness area 409, is located  
5 near the proximal end 407 of each of the movement members 403. A linear hinge is particularly advantageous to achieve enhanced, or even substantially maximum theoretical, axial movement.

The IOL 400 can be used in place of the various second  
10 optic/movement assembly subcombinations noted above. One distinction between IOL 400 and these other subcombinations is the use of four (4) individual movement members 403 which do not totally circumscribe the optic 401 relative to the movement assemblies noted previously which fully  
15 circumscribe the second optics. It should be noted that the movement assemblies of the present ILCs can have other configurations, for example, which are effective to facilitate or even enhance the movement of the second optics.

20 While this invention has been described with respect to various specific examples and embodiments, it is to be understood that the invention is not limited thereto and that it can be variously practiced within the scope of the following claims.



What is Claimed is:

1. An intraocular lens combination comprising:  
a first optic having a negative optical power and adapted to be placed in a substantially fixed position in a mammalian eye;  
5 a second optic having a higher optical power than the first optic; and  
a movement assembly coupled to the second optic and adapted to cooperate with the eye to effect accommodating movement of the second optic in the eye.
2. The combination of claim 1 wherein the second optic has a positive diopter power.
3. The combination of claim 1 wherein the optical powers of the first and second optics provide a net plus optical power.
4. The combination of claim 1 wherein the movement assembly comprises a member including a proximal end region coupled to the second optic and a distal end region extending away from the second optic and adapted to contact  
5 a capsular bag of the eye.
5. The combination of claim 1 wherein the second optic is adapted to be positioned in a capsular bag of the eye.
6. The combination of claim 5 wherein the first optic is coupled to a fixation member adapted to assist in fixating the second optic in the eye and having a distal end portion extending away from the first optic.

7. The combination of claim 6 wherein the distal end portion is adapted to be located in the capsular bag of the eye.

8. The combination of claim 6 wherein the distal end portion is adapted to be located in contact with a sulcus of the eye.

9. The combination of claim 6 wherein the distal end portion is adapted to be located in an anterior chamber of the eye.

10. The combination of claim 6 wherein the fixation member and the movement assembly are secured together.

11. The combination of claim 10 wherein the movement assembly includes a distal end region extending away from the second optic, and the fixation member and the movement assembly are secured together at the distal end portion  
5 and the distal end region.

12. The combination of claim 1 wherein the first optic is adapted to be located anterior in the eye relative to the second optic.

13. The combination of claim 1 wherein the movement assembly circumscribes the second optic.

14. The combination of claim 1 wherein the first optic is adapted to be located posterior in the eye relative to the second optic.

15. The combination of claim 14 wherein the first optic is adapted to be positioned in contact with a posterior wall of a capsular bag of the eye.

16. The combination of claim 1 wherein the optical power of the first optic and the optical power of the second optic are controlled to provide vision correction and accommodation in the eye in which the optics are  
5 located.

17. An intraocular lens combination comprising:  
a first optic having a posterior surface adapted to be positioned in contact with a posterior wall of a capsular bag of an eye, the first optic having a  
5 substantially plano optical power or a negative diopter power;

a second optic adapted to focus light toward a retina of the eye; and

10 a movement assembly coupled to the second optic and adapted to cooperate with the eye to effect accommodating movement of the second optic in the eye.

18. The combination of claim 17 wherein the first optic is adapted to be placed in a substantially fixed position in the eye.

19. The combination of claim 17 wherein the posterior surface of the first optic is configured to substantially conform to a major portion of the posterior wall.

20. The combination of claim 17 wherein the posterior surface of the first optic is configured to substantially conform to substantially all of the posterior wall.

21. The combination of claim 17 wherein the first optic has a substantially plano optical power and the second optic has a far vision correction power..

22. The combination of claim 17 wherein the first

optic has a negative optical power and the second optic has a positive optical power so that the optical powers of the first and second optics provide a net plus optical power.

23. The combination of claim 17 wherein the first optic includes an anterior surface and at least one projection extending anteriorly from the anterior surface, the at least one projection being positioned to limit the posterior movement of the second optic in the eye.

24. The combination of claim 17 wherein the movement assembly comprises a member including a proximal end region coupled to the second optic and a distal end region extending away from the second optic and adapted to contact  
5 the capsular bag of the eye.

25. The combination of claim 17 wherein the movement assembly circumscribes the second optic.

26. The combination of claim 17 wherein the first optic and the movement assembly are secured together.

27. The combination of claim 17 wherein the first optic and the movement assembly are permanently secured together.

28. The combination of claim 17 wherein the first and second optics and the movement assembly are deformable for insertion through a small incision in the eye.

29. The combination of claim 17 wherein the movement assembly is sufficiently flexible to facilitate movement of the second optic in the eye upon being acted upon by the eye.

30. The combination of claim 17 wherein the movement assembly includes a hinge assembly.

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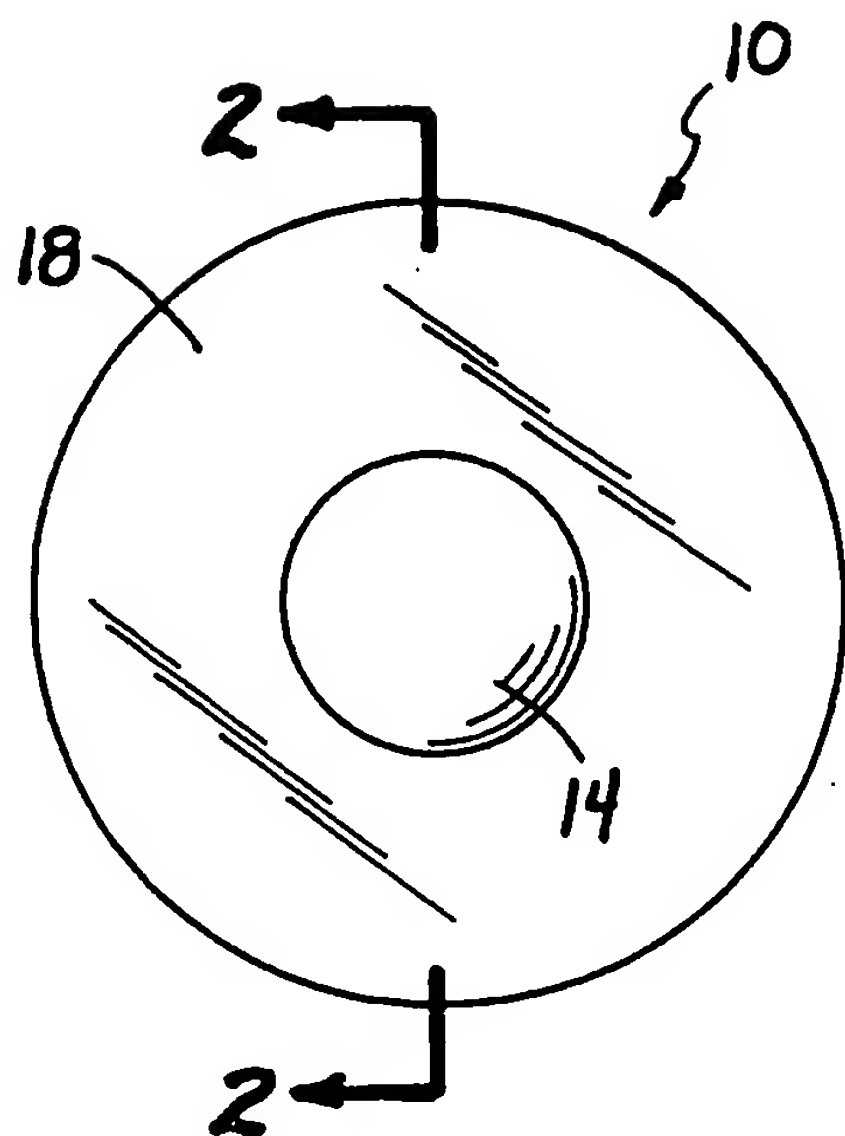


Fig. 1

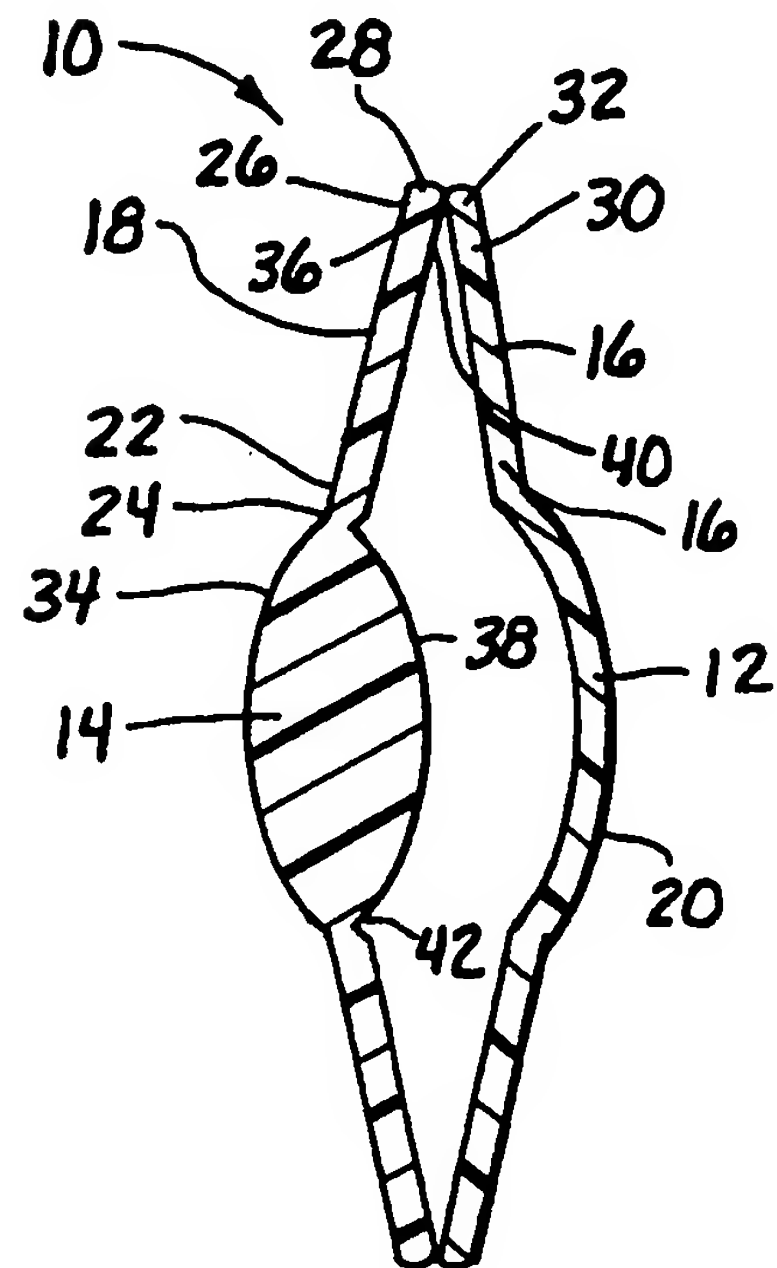


Fig. 2

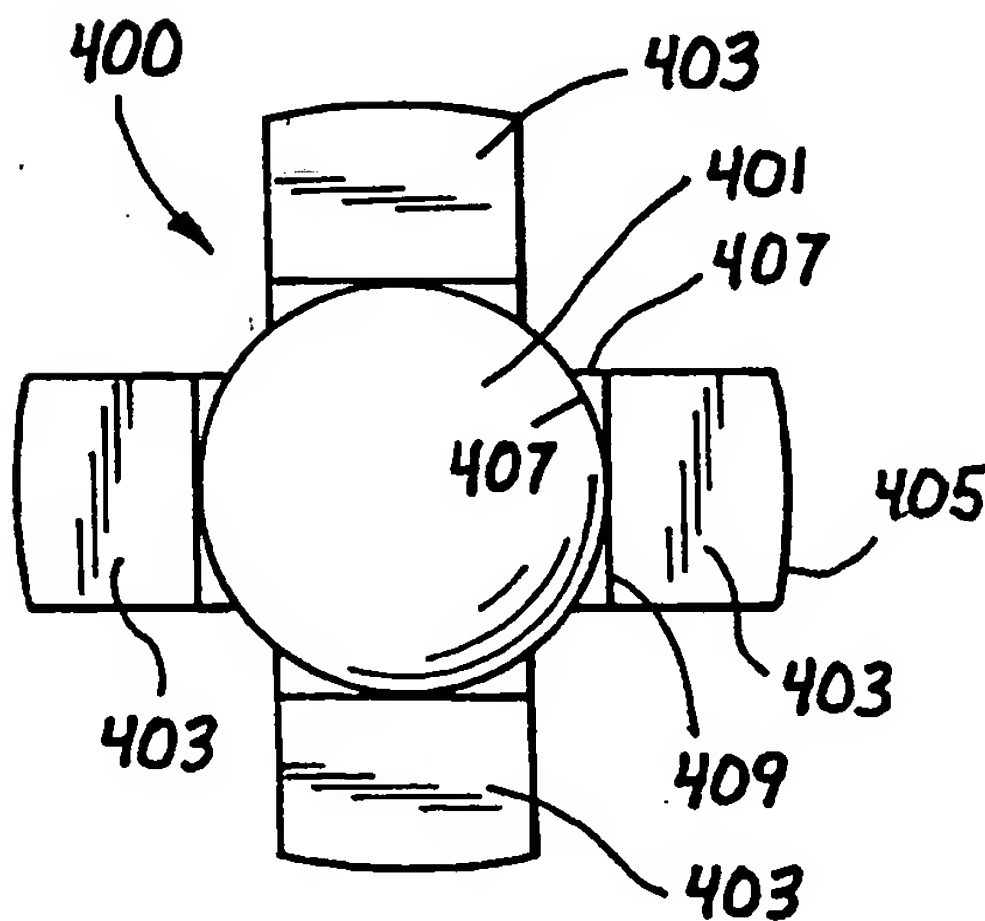


Fig. 6

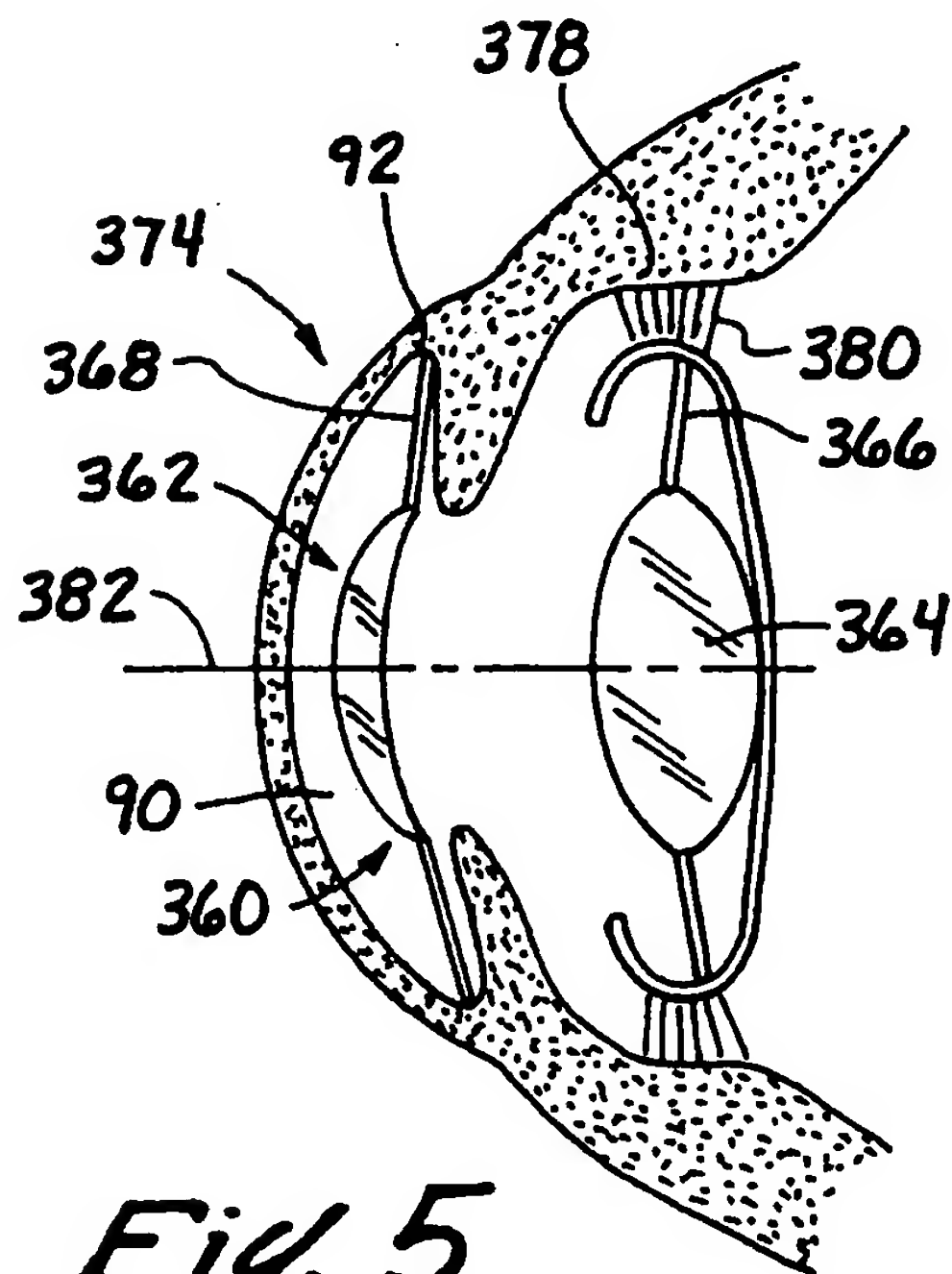
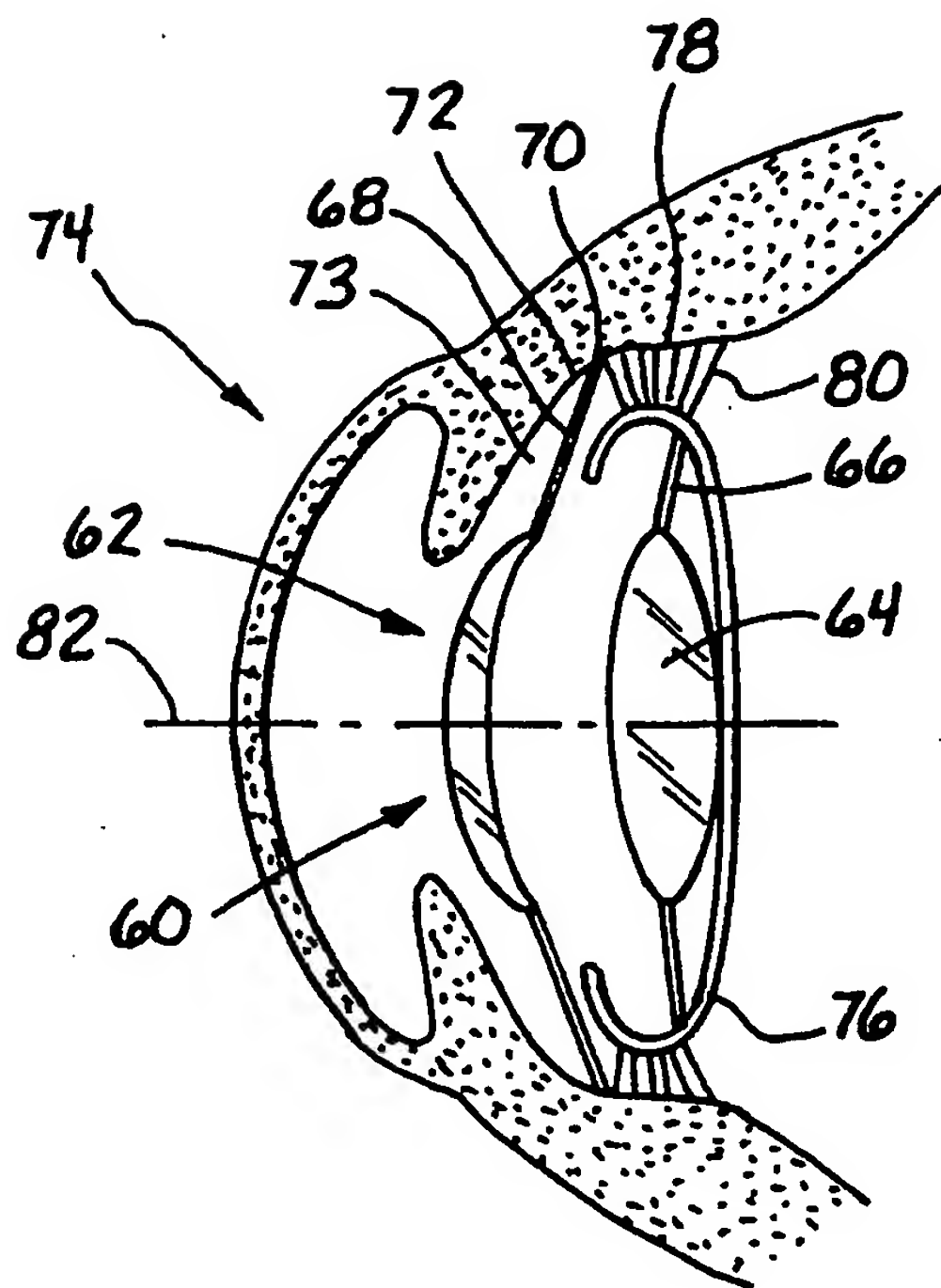


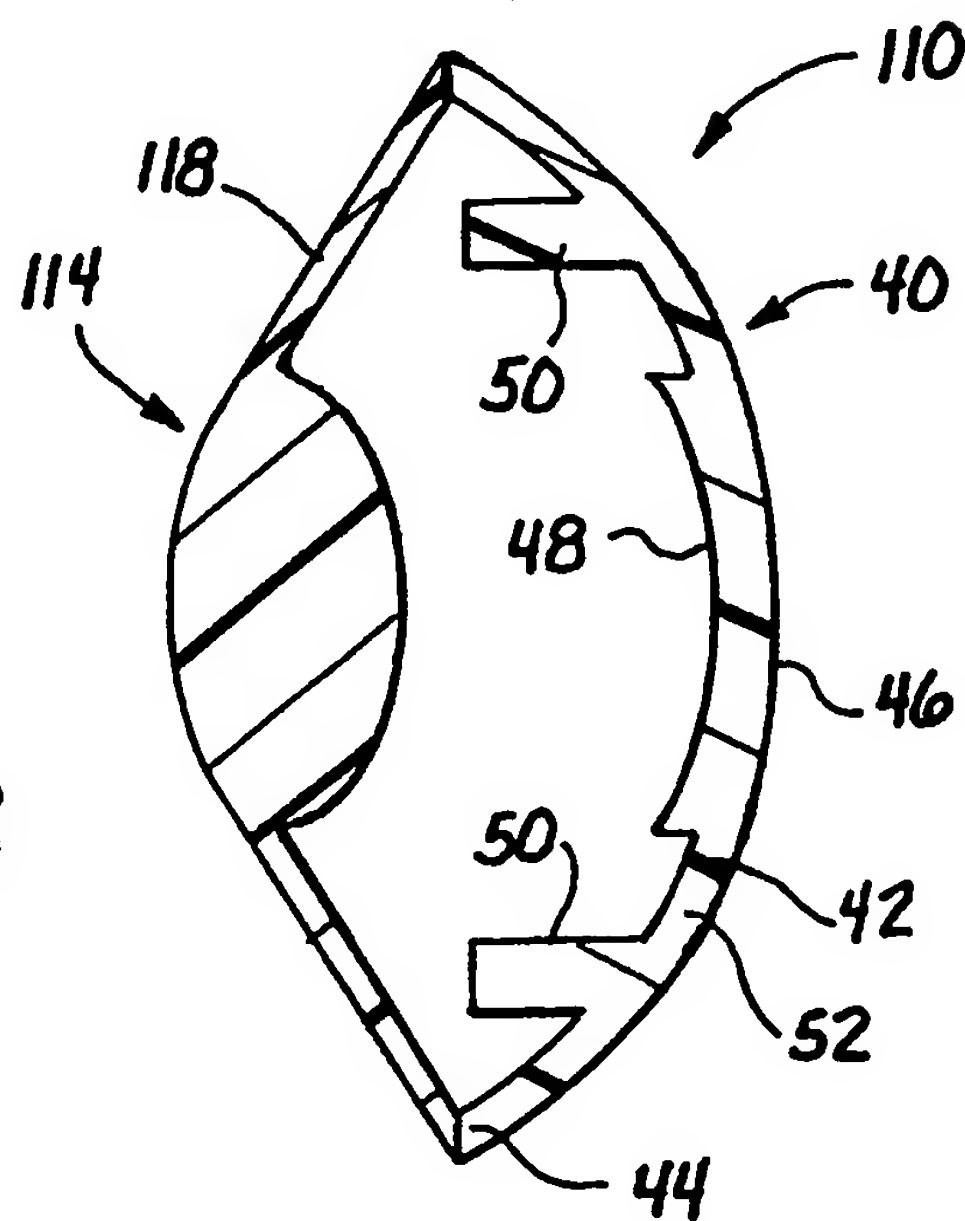
Fig. 5



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*Fig. 4*



*Fig. 3*

# INTERNATIONAL SEARCH REPORT

I. International Application No  
PCT/US 00/11565

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A61F2/16

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 275 623 A (SARFARAZI FAEZEH) 4 January 1994 (1994-01-04)  claims 1-3,22; figures 1,3,4,8 column 4, line 26 - line 52	1,4-7, 10, 12-21, 24-29
A	---	11
A	US 4 892 543 A (TURLEY DANA F) 9 January 1990 (1990-01-09)  claims 1,5,6; figures 2,3,6 column 3, line 12 - line 29 column 4, line 17 - line 34 column 4, line 65 -column 5, line 4  --- -/--	1-7,10, 11, 13-15, 17-19, 21-30

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

1 September 2000

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

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# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 00/11565

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 4 994 082 A (RICHARDS WILLIAM D ET AL) 19 February 1991 (1991-02-19)</p> <p>figures 3-6 column 6, line 58 -column 7, line 55 column 8, line 67 -column 9, line 4 ---</p>	<p>1,4,6-8, 10,11, 17,18, 24-27</p>
A	<p>EP 0 337 390 A (CESKOSLOVENSKA AKADEMIE VED) 18 October 1989 (1989-10-18)</p> <p>claims 1-4,12-14; figures 1-3 column 2, line 37 - line 45 ---</p>	<p>1,4-7, 10,11, 13, 15-20, 23-27</p>
A	<p>US 5 769 890 A (MCDONALD HENRY H) 23 June 1998 (1998-06-23)</p> <p>claim 4; figures 1,4 column 1, line 43 - line 47 column 3, line 3 - line 13 column 3, line 40 - line 58 -----</p>	<p>1-5,12, 14, 16-18, 21,22, 24,28-30</p>

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Information on patent family members

International Application No  
PCT/US 00/11565

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